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An aspiration type model of the interaction between man and an environment

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AN ASPIRATION TYPE MODEL OF THE INTERACTION BETWEEN MAN AND AN ENVIRONMENT

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AN ASPIRATION TYPE MODEL OF THE INTERACTION

BETWEEN MAN AND AN ENVIRONMENT

by

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ABSTRACT

This thesis represents the beginning of a project that will study the behavior of emerging nation - states. The project purposes to reason by induction and analogy from the individual to the nation by aggregating individual needs, abilities, knowledge and decision rules in much the same manner that economists move from the micro-economics of the individual to the macro-economics of the nation.

This thesis reports the work to date. It consists of a description of a simple aspiration model of man in an environment barren of all social interactions. The thesis represents man's efforts to utilize his environment to provide the essentials for survival by modeling the interface between man and the environment in terms of man's needs, abilities, knowledge, and decision rules.

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1. Introduction.

This thesis represents the beginning of a project by the author whose purpose is a study of the behavior of emerging nation - states.

Initially the author devoted considerable time to searching the literature and exploring the range of disciplines that seemed to bear on the topic, in particular the areas of economics, political science, and sociology. This initial investigation brought home the fact that relatively few authors have approached the problem of national development on an interdisciplinary level. Economists generate volumes of input-output analyses and political scientists discuss at length the transition of power, while sociologists, in general, concern themselves with the "micro-sociology" of the family or community. Seldom are these disciplines seen together in print. All of these disciplines have developed insights into the workings of a nation - state, their weakness is that each stands alone, lacking the strength that could be derived from embracing other disciplines.

Notable exceptions to the above generalization have come from Hagen [23] , Doob [13] , Erasmus [18] and Goodenough [21] . These authors have investigated the nature of social and cultural change and are representative of the inter disciplinary effort in this area since 1960. These writings give some hint of the advantages of an interdisciplinary study of the behavior of nations. It is hoped

that this project will encompass the thinking of as many disciplines as can offer significant insights into the behavior of emerging nation - states.

Reviewing the concepts of national development it becomes clear that the common denominator of the effort is man. The economists, the sociologist,the political scientist,each examines man in a different context, but all examine man. Government and economies exist because of and for man. It is evident that to understand the development of nations one first must understand the development of man in a social context.

The project posed as simply as above, is deceiving. The task of synthesis and of crystallization of the many concepts of national behavior is monumental, however, the project has been divided into six phases and will be undertaken in manageable segments. This thesis reports the work of the first phase.

This thesis presents a model of an individual man alone in an environment barren of all facets of social interaction. The model represents man's efforts to utilize his environment to survive in terms of individual needs, abilities, knowledge and decision rules. The model is a simple aspiration model and while it incorporates abstractions, temptations to develop a more elegant model have been resisted because it is felt that the essentials of man's behavior in an environment without social interactions can be represented by a model of the interface

between needs and abilities and because at the same time a simple model will introduce fewer problems when, in later phases, the model is aggregated to represent groups of men.

The second phase of the project will introduce two men, each represented by the model developed in this thesis, into an environment again devoid of social interactions. The project will investigate the interaction of the two men as they utilize the same environment to provide the essentials for survival. It is hypothesised that this phase of the project will develop the basis for and an understanding of the phenomeon of cooperation and conflict.

The next phase of the project will introduce a group of men, modeled as an aggregation of the individual modeled by this thesis. In addition the model will be structured as necessary to simulate the roles the group might adopt to control the cooperation and/or conflict demonstrated by the previous phase of the project. It is hypothesised that this phase of the project will be able to analyse the elementary functions of government and their ability to support the needs of men. During this phase of the project the model of man will be expanded to represent not only the interaction between man and his environment but also the interaction between man and other men.

Phase four of the project will introduce the structure necessary to represent the functions of an economy. It is hypothesised that as the number of men modeled increases and/or as the geographic extent of the modeled environment increases it will be necessary for the institutions of

industry and trade to be introduced if the group of men are to be able to utilize the environment in a manner that will provide the essentials for survival for all.

The fifth phase of the project will consider the elementry functions necessary to allow a group of individuals to pass their knowledge to their descendants. It is hypothesised that a successful nation must incorporate institutions that can provide not only for it's citizens of the present but also for it's citizens of the future, thus the functions of education will be incorporated into the model at this phase.

The final phase of the project will synthesize the efforts of all earlier phases. Aggregated individuals will be represented in an environment modeled to represent not only the physical world but also the social functions of control, economy, and education. It is hypothesised that certain minimum requirements can be shown to exist if these three social institutions are to structure the group to allow each individual to be able to derive from the environment and the group those things he needs for survival.

This thesis is presented in five sections. Section one provides a brief description of the six phases of the project. Section two begins the report of the work to date. It consists of a description of a simple aspiration model of man in an environment barren of all social interactions. The model represents man's efforts to utilize his environment to provide the essentials of survival by modeling the interface between man and the environment in terms of man's

needs, abilities, knowledge, and decision rules. Section two reports the study's definition of environment, need, ability, knowledge, and decision rule. Section three describes the dynamics of the model and offers a heuristic demonstration of the requirements necessary for an equilibrium to exist in the model. Equilibrium at this point represents man's ability to derive the essentials of survival from the environment. Section four examines the conditions for equilibrium in some detail, considering the effect of changes in the levels of the exogenous variables. Changes in these variables are represented and their effect upon the equilibrium of the model is investigated. Section five summarizes the study and points to the next step in the over all effort. A selected bibliography is included that is representative of the range of literature concerned with the subject of the behavior of emerging nation - states.

2. Elements of the Model

Environment

Environment in this thesis is modeled to represent a portion of the physical world. Environment is represented by describing the dimensions or attributes of the geography and flora and fauna of some portion of the physical world. Specific examples of the flora and fauna are called environment elements and are represented by an n-tuple each of whose components describes one dimension or attribute of the portion of the environment it represents. The thesis specifically utilizes two of the components. It is assumed that the remaining components will be detailed when appropriate during later phases of the project.

Environment elements and their components are represented as below:

E_y	y^{th} element of the environment
E_y^i	i^{th} component of the y^{th} element
E_y^1	physical distance from man, a measure of distance
E_y^2	utilization potential, a measure of quantity

Elements of the environment are modeled to simulate periodic changes associated with the location on earth they represent. The passage of night and day and seasonal transitions are represented by changes in the environment elements in accordance with some periodic function.

Additionally, the elements may experience random change representing such events as earthquakes or unnatural extremes of climate.

Thus the environment once defined by a set of environment elements and a set of initial conditions will change in accordance with functions representing the cycles of the universe and the occurrence of random events.

It is assumed that the man modeled in the study will utilize elements of the environment to satisfy his needs, once utilized these elements are removed from the environment. The possibility that man may be motivated to modify certain elements of the environment to satisfy his needs is recognized, but will not be modeled at this point in the project.

Man

The model represents the efforts of man to aquire and utilize elements of the environment in order to provide the essentials for survival. The model represents the behavior of man in terms of four factors: need, ability, knowledge and decision rules.

Need

Needs can be classified as vital needs and aquired needs. This study considers only vital needs. Vital needs are needs that are literally vital to man's existance. If vital needs remain unfulfilled man can not survive.

Man's needs have been investigated by scientists. It is known, for example, that man needs a variety of foods

to provide the necessities for life. It is known that man's need for protien places man (and all animals) in need of plant life. It is known that man's body chemistry needs water to function properly. The above facts illustrate the manner in which science has demonstrated some of man's needs.

It should be noted that the above reflects only a portion of man's understanding of his vital needs and that it is not necessary for man to understand his needs in order for him to behave as if he understood them. Man searches out food in response to some nebulous feeling called hunger; he knows he needs food even if he does not know why. The model incorporates this internal mechanism by assuming that man can determine his needs as outlined in the following paragraphs.

It is assumed that for each of man's needs there exists a Desired Need Level, $\bar{N}$, at which that need is satisfied. The determination of the desired need level is exogenous to this model and desired need levels once introduced will remain fixed.

Additionally, for each need the model incorporates a Need Time, T, a length of time during which an unfulfilled need must be satisfied if man is to survive. Need times are determined exogenously and once introduced are fixed. Thus each of man's needs can be represented by an ordered pair, Desired Need level, Need time, $(\bar{N}, T)$.

The actual need level determined by man is represented

in the model with the symbol, N_{ik}, where the subscript i denotes the i^{th} need during time period k as determined by the mechanism internal to the model of man. In summary:

$\bar{N}_i$ represents the desired need level of the i^{th} need, a number determined exogenously to indicate a level at which the need is said to be satisfied.

T_i represents the need time of the i^{th} need a number determined exogenously to indicate the time during which man must satisfy need i if it is unfulfilled.

$(\bar{N}_i, T_i)$ represents the two demensions of the i^{th} need, the level at which it is satisfied $\bar{N}_i$ and the time allowed to satisfy the need T_i if it is unfulfilled.

N_{ik} represents the actual need level of the i^{th} need during time period k.

A need is satisfied if the actual need level is equal to or greater than the desired need level. Thus $\bar{N}_i \leq N_{ik}$ implies need i is satisfied in the k^{th} period. Correspondingly, $\bar{N}_i > N_{ik}$, implies need i is unfulfilled during time period k.

If a need is unfulfilled at sometime, it must be satisfied within the need time if man is to be represented as surviving. In summary:

$N_{ik} < \bar{N}_i$ & $N_{ik+T} \geq \bar{N}_i$ represents a set of conditions which indicate that a need unfulfilled

at time $k+T$ has been satisfied by time within the need time.

$N_{ik} < \bar{N}_i$ & $N_{ik+T} < \bar{N}_i$ represent a set of conditions which indicate that a need unfulfilled at time k has not been satisfied by time $k+T$ thus man does not survive.

Desired need levels can be thought of as aspirations levels and in this context they represent minimum levels of attainment.

The model incorporates the assumptions that the needs of man can be partitioned into a finite number of categories and that all actual need levels and desired levels are measured on the same scale. This scale will represent quantity and will be modeled as the real line.

It is assumed that man will not utilize the elements of his environment unless he is motivated by an unfulfilled need and further that if man is confronted with more than one unfulfilled need he will act to satisfy all needs as quickly as possible.

The difference between the desired need level and the actual need level $(\bar{N}_i - N_{ik})$ will be called the motivation level, M_{ik}, where the subscript i represents the i^{th} need and k represents the k^{th} time period.

The more general notion of motivation includes not only the motivation level but also the need time in which the unfulfilled need must be satisfied if the man is to survive. The general concept of motivation will be

represented by the ordered pair; Motivation level, Need Time (M_{ik}, T_i).

Ability

Ability is represented by a set A, each element A^i of which models one of the mental or physical capabilities of the individual represented in the study. Elements of the ability set represent fixed levels of ability for each of the capabilities. It is assumed that the ability levels modeled in this study have been selected from distributions representive of the entire range of human ability.

Only one element of man's ability set is specifically defined in this thesis. The remaining elements will be defined during later phases of the project, as appropriate. The defined element is man's capacity for movement measured as a rate (ft/sec). In summary:

A^i represents the i^{th} element of man's ability

A^1 represents man's capacity for movement, measured as a rate, ft/sec.

The model abstracts from the problem the degradation of capabilities due to fatigue, aging and illness and the increase of capabilities due to the learning of physical skills or development of physical capabilities.

Two restrictions are placed on man's mental ability. Once man has aquired knowledge he does not forget and man is unable to percieve of the future.

Man's physical ability is clearly important to the

model for it defines the extent of his environment and thus the number of elements in the environment potentially useful to him. If man is unable to move to a portion of the environment it is as if that portion of the environment did not exist.

Man's mental ability is equally important, specifically the capacity of man's senses to perceive. All man learns of his environment is derived from his capacity to percieve his environment and his capacity to organize his perceptions.

Decision Rules

Man's decision rules are represented in the model by a set of rules that determine which of any set of alternative courses of action will be pursued.

Two decision rules are specifically defined in this phase of the project. It is assumed that man will remain inactive until motivated by one or more unfulfilled needs. Further it is assumed that once confronted with an unfulfilled need man will choose to satisfy the unfulfilled need by selecting an element of the environment that can satisfy the need within the need time. The implications of these rules are described in Section 3.

Knowledge

The man represented by the model has an initial stock of knowledge. This knowledge is of two types, identification and understanding. Identification represents knowledge of the components of the n-tuple representing an environment element. Understanding represents knowledge

that a specific environment element can be utilized to satisfy one of man's needs.

The model allows man to add to his stock of knowledge by organizing his perceptions of the environment. During each time period man experiences a number of sensations by way of his sense organs. These sensations allow man to become aware of the dimensions and attributes of the various elements. The dimensions and attributes of the elements are represented by the component of an n-tuple. Gradually man will accumulate sensations that will make him aware of all the components of a specific environment element. When man has knowledge of all of the components of an environmental element man is said to have identified that element.

The process of identification is modeled in the following manner. Man perceives a set of sensations, S, during some time period, each element, s, of this set represents a specific sensation about a specific environment element during the time period, thus each element of the set of sensations is also a component of some environment element. At each time period man examines the sensation of all previous time periods and extracts all sensations pertaining to the same environment element, $\bigcup_{j=1}^{k} s_{yij}$, if man has a complete set of components for some environment element $\bigcup_{i=1}^{3} E_y^i$ man has identified that element and it is added to his stock of identification knowledge. In summary:

S_k a set of sensations percieved during time period k

s_{yik} an element of S_k representing a sensation of the y^{th} environment element's i^{th} component during time period k

E_y^i is the i^{th} component of the y^{th} element thus s_{yik} is the same as E_y^i

$\bigcup_{j=1}^{k} s_{yij}$ represents mans procedure of examining all sensations he has received.

$\bigcup_{i=1}^{n} E_y^i$ represents all the components of environment element y. It is a set containing the dimensions and attributes of environment element y.

$\bigcup_{i=1}^{n} E_y^i \subset \bigcup_{j=1}^{k} s_{yij}$ represents the conditions for identification. If the set of components of environment element is contained in the set of perceptions received by man to time , man has identified environment element .

Man discovers that an environment element can be utilized to satisfy a need by comparing the newly identified element with elements from his stock of understanding knowledge. If the new element is the same as, or "almost" the same as, an element of the understanding stock man incorporates the new element into his stock of understanding as an element that

is capable of satisfying the same needs as the "reference" element from the original stock of understanding.

This procedure is represented in the model as follows. The components of the new element and the reference element are compared component by component and the difference between the two components is noted, $\left|E_y^i - E_z^i\right|$, if the largest difference is less than some number, $\bar{\Delta}$, representing the quality of mans senses, man treats the new element as if it were the "reference" element. Delta bar is the model's way of representing the quality of man's sensors. If delta bar is small,man can distinguish clearly between different environment elements. If delta bar is large, the man is unable to make fine distinctions between environment elements. In summary:

E_y^i the i^{th} component of environment element y, the newly identified element.

E_z^i the i^{th} component of environment element z, a element from the understanding stock. The reference element.

$\left|E_y^i - E_z^i\right|_{i=1\ldots n}$ represents the comparisons of the elements component by component. Note the we are interested in the magnitude of the difference not the sign.

$\max\limits_{i=1\ldots n}\left|E_y^i - E_z^i\right|$ represents the largest difference between components of the new and reference elements.

$\bar{\Delta}$ a number representing quality of man's sensors.

$\max_i \left| E_y^i - E_z^i \right| \leq \bar{\Delta}$ represent the condition for man to recognize element y as being the same as element z. If the magnitude of the largest difference between the component of the new element and the reference element is less than or equal to some number, man treats the new element as the reference element.

Man may understand a new element to be the same as more than one reference element from his stock of understanding. This condition represents the fact that a specific element of the environment may be used for more than one purpose, in particular to satisfy more than one need.

If the difference represented above is greater than delta bar but less than or equal to another number representing man's willingness to accept the risks of utilizing elements he does not understand, man's behavior can be modeled as trial and error learning. Delta double bar here represents the risk of trial and error learning, a risk inherent in the nature of the situation modeled by this study. Man alone in an environment must experiment, must resort to trial and error learning, if he is to add to his stock of understanding. There are no schools or books to pass on the knowledge of others, there are no others to watch and learn from by example. Trial and error learning

represents a risk to the man because he has no way of knowing that the elements of the environment he has identified can be used to satisfy his needs, he can only try then and expose himself to the possibility that the element may be useless or perhaps hazardous to him. The model incorporates this behavior by the procedure summarized below.

$\max_i |E^i_y - E^i_z|$ represents the comparison of the components and the selection of the largest difference.

$\bar{\bar{\Delta}}$ is a number determined exogonously that represents mans willingness to accept the risk of trial and error learning.

$\bar{\Delta} < \max_i |E^i_y - E^i_z| \leq \bar{\bar{\Delta}}$ is a condition that represents the fact that man has identified an element of the environment and although he does not understand it, it is similar enough to an understood element that man is willing to accept whatever risks may be involved in using the element to satisfy needs.

If the above condition holds the newly identified element may be utilized to satisfy a need in accordance with man's decision rules. If the element satisfies the unfulfilled need, the element will be introduced to mans stock of understanding knowledge. If the element does not satisfy the unfulfilled need, man can not survive.

$\bar{\bar{\Delta}} < \max_i |E^i_y - E^i_z|$ is a condition that denies to man the

possibility of utilizing the newly identified element to satisfy his needs.

If the above condition holds the newly identified element is not forgotten and the process summarized above will be repeated in its entirety during succeeding time periods.

3. Dynamics of the Model.

Man and the environment are in equilibrium if man's needs are satisfied or if man can aquire and utilize elements of the environment to satisfy unfulfilled needs in times less than the need times of the respective needs. In summary:

If $\bar{N}_i \leq N_{ik}$ for all i and all k ; the model is in equilibrium. The condition requires that the actual need level of all the needs be greater than or equal to the desired need level during all time periods.

If $\bar{N}_i > N_{ik}$ and $\bar{N}_i \leq N_{ik+T}$ for all i the model is in equilibrium. The condition requires that all actual need levels, If less than the desired need levels during period k , must be greater than or equal to the desired need levels during the period $k+T$ time T later than the original time period.

During each time period there are elements in the environment that man can aquire and utilize to satisfy his needs, these elements we designate resources. Some resources man can utilized to satisfy one need, some he can utilize to satisfy several needs. The resources associated with the satisfaction of a particular need we designate a resource-need set. In summary:

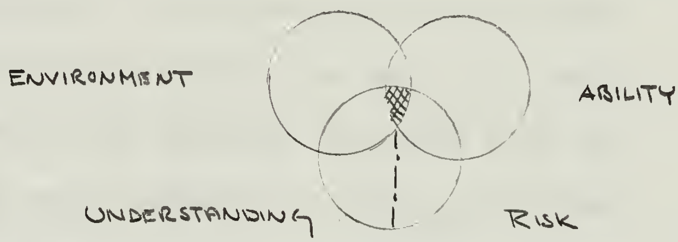
$\mathbb{R}$ the set of resources

R/N_i is a resources-need set associated with the i^{th} need.

$\bigcup_{i=1}^{n} R/N_i = \mathbb{R}$ the combination of all resource-need sets creates the set of resources.

Each resource need set is generated as an intersection of three sets. A set of elements present in the environment during a specific time period. A set of elements man can physically aquire and utilize. A set of elements belonging to man's stock of understanding and of elements man has identified and whose utilization he is willing to risk.

symbolically:



Consider how these elemental sets are formed. The set of elements in the environment is defined initially along with the manner in which these elements will change within the environment. Thus elements initially defined as being present in the environment may disappear and then reappear in accordance with some function. The model allows environment elements to change in one of three ways. First, in accordance with rules that represent the daily or seasonal changes. These rules would allow for the periodic appearance and disappearance of some environment elements. Second,

elements may be removed from the environment by man. These elements would reappear in the environment in accordance with the periodic rules suggested above. Finally, a random event may "destroy" all the elements in some portion of the environment. The reappearance of these environment elements would depend upon the amount of destruction and the periodic rules cited above.

The set of elements that man is capable of aquiring and utilizing is not time dependent. Man's capabilities as defined in the model are constant. Anything man can do in one time period he can do in another time period. An element that man can aquire and utilize during any time period is an element of this set regardless of whether or not it is in the environment at present.

The set of elements about which man has knowledge never decreases. Since man in the model can not forget, the number of elements in the set must either increase or stay the same. Elements assigned to this set are elements that man has incorporated into his stock of understanding and elements that man has identified and whose utilization man is willing to risk in order to satisfy some specific unfulfilled need. Some elements of the environment belong to several knowledge sets since some elements are capable of satisfying different specific needs.

Each time period furnishes man with an additional set of sensations and thus with additional potential understanding of his environment. In the model as in life time provides

man with the potential for increased knowledge.

The sets of elements described above can be defined for any time period. The intersection of the three elemental sets defines for man a set, the elements of which are capable of satisfying unfulfilled needs at a given time. The elements included in the set, the resource-need set, will vary as the elements of the elemental sets.

The above discussion illustrates the construction of resource needs sets as they exist in the model. Consider now the process by which the model allows man to choose the specific element of the appropriate resource-need set to satisfy some unfullfilled need.

During some time period man compares the actual need level with the desired need level of all of his needs and determines the motivation that exists. Having determined the motivation that exists he selects elements from the appropriate resource need set in a manner that can be represented as follows:

Each element of each resource-need set represents an element of the environment and as such is an n-tuple each component of which is a dimension of the element. Man considers two of these components, distance from man and utilization potential. For each element he forms the ratio of distance from man over man's ability E_{ij}^1/A^1 to generate a time called Time To Utilize, t. Then he compares the satisfaction potential, time to utilize pair (E_{ij}^2, t) with the motivation level, need time pair (M_{ik}, T_i) and selects those

elements that can satisfy his needs in the appropriate time.

To examine the dynamics of the model consider a scenario in which man for some time has existed in an environment by utilizing certain elements of the environment to satisfy his needs. The conditions for equilibrium defined earlier hold.

$$\bar{N}_i \leq N_{ik} \quad \text{for all } i$$
$$\text{OR}$$
$$\bar{N}_i > N_{ik} \;\&\; \bar{N}_i \leq N_{ik+T}$$

An event occurs that removes the environment elements that man had been using to satisfy his needs. The model utilizes the following mechanism to satisfy the unfulfilled needs. At some time after the event man determines the actual need level of his needs and compares them with the desired need levels. At time $t+1$, (M_{1t+1}, T_1) and $(M_{2,t+1}, T_2)$ exist. Man then examines the elements of resource-need set one and two and performs the following operations on each element.

$E_{j1} \subset R/N_1$ shows that E_{j1} belongs to the first resource need set. It represents one of the elements of a set of elements each of which is capable of satisfying need number one.

$E_{j2} \subset R/N_2$ shows that E_{j2} belongs to the second resource need set, it represents one of the elements of a set of elements each of which is capable of satisfying need number two.

$E^1_{j1}/A^1 = t_{j1}$ is the time to utilize element j to satisfy need one.

Man then forms a reduced resource-need set. A set of elements capable of satisfying his needs.

R/N^t_i is the reduced i^{th} resource-need set at time t

$$E_j \subset R/N^t_i \text{ if } t_{ji} < T_i \;\&\; E^2_j \geq M_i t \;\&\; E_j \subset R/N_i$$

man then chooses those elements from each set that allow him to satisfy all of his needs in the shortest possible time. This decision rule can be expressed:

$$\text{Min.} \sum_{i=1}^{n} t_i$$

subject to the constraint

$$\sum_{j=1}^{i} t_j < T_i$$

The above rule allows man to satisfy his needs serially and requires that the need be satisfied in some sequence. It is assumed that man satisfies his needs within the required time frame and in the sequence specified by the decision rule.

If the model is in equilibrium resource elements exist that allow man to follow the above procedures with the result that both needs are satisfied by the time period

It should be noted that the environment elements utilized in the above discussion to satisfy needs could be elements that man has identified and whose utilization he is willing to risk. If the environment element is successfully utilized man's stock of understanding will be increased

accordingly. If the environment element is not capable of satisfying the unfulfilled need the model will be out of equilibrium and man will not survive.

4. The Affect of Changes in the Exogenous Variables.

The previous section detailed the dynamics of the model and showed heuristically that an equilibrium exists for the model at some level of the exogenous variables. Specifically it can be shown that the variables representing man's ability to move A^1 Need Time T_i and distance from man $\bar{E}^1_y$ must be related so that the distance from man is less than the product of the need time and the ability of man to move if an element of the environment is to be utilized by man to provide himself with the essentials for survival. If man is to survive there must be some portion of the environment that satisfies this condition. In summary:

$E^1_y < T_i A^1$ This condition shows the environment element a distance from man less than the distance represented by mans ability to move in the need time.

Additionally the various exogenous variables must satisfy the condition represented below:

$$0 < \bar{N}_i - N_{ik} < \bar{E}^2_y \quad \text{or} \quad M_{ik} < \bar{E}^2_y$$

This condition requires that if a need is unfulfilled there must be an environment element whose utilization potential is greater than the quantity needed to satisfy the unfulfilled needs.

Considered together the two conditions require that the exogenous variables be in such proportions as to allow

man to aquire and utilize some element of the environment quickly enough to satisfy his unfulfilled needs.

It is to be emphasized that the exact level of the exogenous variables are unimportant, rather the proportions of the variables are important. If man's capability is increased the environment elements can be more distant, if man's needs are reduced environment elements can have reduced utilization potential.

It is instructive to consider the effect upon the model of a change in any one of the exogenous variables. For this consideration the model will initially be assumed to be in equilibrium and the variables will be considered in the order in which they were introduced in Section 2.

Two dimensions of the environment have been specifically defined, distance from man and utilization potential. A change in the environment could be represented by a change in these components of the environment elements. A harsher environment could be represented by either an increase in the distance from man or a decrease in the utilization potential, indicating that resources are scarce in the environment or that the resources that do exist are relatively unable to satisfy man's needs. Clearly if all other variables remain constant the environment can be represented as being so harsh that the model can have no equilibrium.

LET $E_y^{1*} = E_y^1 + \alpha$ where E_y^{1*} is the new distance from man and α represents the increased distance from man.

$$\text{if } E_y^{1*}/A^1 = t_y^* < T_i$$
$$E_y^{1+\alpha}/A^1 < T_i$$
$$E_y^{1}+\alpha < T_i A^1$$
$$E_y^1 < T_i A^1 - \alpha$$

Clearly α can be made so large that the inequality does not hold. If the inequality is destroyed the condition that represents man's ability to move to the desired element of environment within the need time is destroyed, thus man can not aquire the element in time to survive.

Alternatively by reducing the utilization potential of the elements

$E_y^{2*} = E_y^2 - \beta$ where E_y^{2*} is the new utilization potential

then $E_y^2 - \beta > M_{ik}$

Again β can be made so large that the inequality does not hold. If the inequality is destroyed the condition that represents the environment's ability to provide the quantity of the element required to satisfy some unfulfilled need is destroyed and man can not survive because he can not satisfy his needs.

This analysis also reveals that changes in the environment that decreased the distance from man or increase the utilization potential can not remove the equilibrium of the model. That is the conditions for equilibrium represented by the inequalities can not be destroyed when the signs of α and β are reversed.

Man's desired need level is defined exogenously and could be defined at some different level. Again this variable could be defined so as to remove the possibility of an equilibrium in the model.

Let $\bar{N}_i^* = \bar{N}_i + \gamma$

if $0 < \bar{N}_i - N_{ik} < E_y^2$

then $0 < \bar{N}_i + \gamma - N_{ik} < E_y^2$

$0 < \bar{N}_i - N_{ik} < E_y^2 - \gamma$

If $\gamma = E_y^2$ the above condition can not hold since a quantity can not at the same time be larger and smaller than zero. Again any decrease in desired need level would not affect the ability of the model to reach an equilibrium.

One element of mans ability set has been defined and represented in the model, the rate at which he can aquire and utilize resources in the environment. A decrease in man's ability could be represented by decreasing the value of this variable

let $A^{1*} = A^1 - \delta \qquad A^1 > \delta > 0$

then $E_y^1 / A^1 - \delta = t_y^* < T_i^*$

$E_y^1 < A^1 T_i^* - \delta T_i^*$

$E_y^1 + \delta T_i^* < A^1 T_i^*$

The inequality can be destroyed unless $E_\gamma^1 = 0$ a case represented by a resource very, very close to man. An increase in man's ability would not reduce the possibility of the model reaching an equilibrium, since the inequality can not be destroyed if the sign of δ is changed.

Decrease in need time would have the following effect

$$\text{let } T_\gamma^* = T_\gamma - \xi \qquad \xi < T_\gamma$$
$$E_\gamma^1/A^1 < T_\gamma - \xi$$
$$E_\gamma^1 < A^1 T_\gamma - A^1 \xi$$

The inequality is destroyed unless E_γ^1 is zero, a situation represented by the resources being very, very close to man. If the need time is increased the possibility of an equlibrium is not hindered. If the inequality is destroyed the condition that represents man's ability to aquire and utilize elements of the environment within the required time is destroyed, thus man is unable to survive.

It is not to be infered from this discussion that these are the only variables that can affect the equilibrium of the model, in addition it is noted that any change of the decision rules will modify the manner in which the model arrives at its equilibrium, that is, a change in the decision rules may cause the model to select different environment elements to satisfy unfulfilled needs. An analysis of the effect of different decision rules is beyond the intent of this thesis.

5. Summary and Conclusion.

This thesis reports the first phase of a project that will investigate the behavior of emerging nation - states. The first phase of the project developed a model of man by representing the interaction between man and his environment in terms of man's needs, abilities, knowledge, and decision rules. The study demonstrated that an equilibrium exists at some combination of the variables representing man's needs and abilities and the variables representing the environment.

It is felt that the work assigned to the first phase of the project has been completed and the author is prepared to move to the second phase of the project and begin an investigation of the basis of cooperation and conflict.

It should be noted that the work of the first phase need not necessarily be followed immediately by the work outlined for the second phase. It may be profitable to investigate the model of learning developed as a by-product of phase one work. The details of this sub-model may offer some value by way of the insights provided into the different types of learning. It is felt that the sub-model provides a realistic representation of learning with out resorting to the traditional response-reinforcement formulation. It is felt that the sub-model should be pursued in a effort to test it's validity in more general circumstances.

Finally it is felt that some value might be gained by examining the model with a different set of decision

rules. The deterministic rules now used, while generating a realistic model, could be replaced by a set of probabilistic decision rules. It is felt that the probabilistic formulation should be investigated, as a sensitivity analysis of the decision rule portion of the model.

BIBLIOGRAPHY

1. Aberle, D. F., Cohen, A. K., Davis, Levy, M. J., and Sutton, F. X. The Functional Prerequisites of a Society. <u>Comparative Politics</u>, ed. Macridis, R. C. and Brown, B. E. The Dorsey Press, 1964: 77-89.

2. Almond,G. A. Comparative Political Systems. <u>Comparative Politics</u>, ed. Macridis, R. C. and Brown, B. E. The Dorsey Press, 1964: 50-64.

3. Almond, G. A. and Coleman, J. S. <u>The Politics of the Developing Areas</u>. Princeton University Press, 1960.

4. Anderson, G. L. ed. <u>Issues and Conflicts</u>. University of Kansas Press., 1959.

5. Arrow, K. J. Mathmatical Model in the Social Sciences. <u>General Systems</u> Vol 1, 1966: 29-47.

6. Bakke, E. W. Adaptive Human Behavior. <u>Industrial Relations Center</u>, <u>University of Mennesota</u>. Bulletin No. 4.

7. Bakke, E. W. Concept of Social Change. <u>General Systems</u> Vol IV, 1959: 95-122.

8. Bell, D. Twelve Modes of Prediction - A Preliminary Sorting of Approaches in the Social Sciences. <u>Daedales</u>, summer 1964: 845-880.

9. Chase, Stewart, <u>Roads to Agreement</u>. Harper and Brothers, 1951.

10. Deutsch, K. W. <u>The Nerves of Government</u>. The Free Press of Glencoe, 1963.

11. Deutsch, K. W. Social Mobilization and Political Development. <u>Comparative Politics</u>, ed. Macridis, R. C. and Brown, B. E. The Dorsey Press, 1964: 641-648.

12. Diesing, P. <u>Reason in Society</u>. University of Illinois Press, 1962.

13. Dool, L. W. <u>Becoming More Civilized</u>. Yale University Press, 1960.

14. Easton, D. The Analysis of Political Systems. <u>Comparative Politics</u>, ed. Macridis, R. C. and Brown, B. E. The Dorsey Press, 1964: 89-102.

15. Easton, D. A Systems Analysis of Political Life. John Wiley & Sons, 1965.

16. Eisenstadt, S. N. Bureaucracy and Political Development. Bureaucracy and Political Development, ed. LaPalombara. Princeton University Press, 1963: 96-119.

17. Emerson, R. Nationalism and Political Development. Comparative Politics, ed. Macridis, R. C. and Brown, B. E. The Dorsey Press, 1964: 573-620.

18. Erasmus, C. J. Man Takes Control. University of Minnesota Press, 1961.

19. French, J. R. P. A Formal Theory of Social Power General Systems Vol II, 1957: 92-101.

20. Friedrich, C. J. Man and His Government. McGraw-Hill, 1963.

21. Goodenough, W. H. Cooperation in Change. Russell Sage Foundation, 1963.

22. Hagen, E. E. A Framework for Analyzing Economic and Political Change. Development of the Emerging Countries. The Brookings Institution, 1962: 11-25.

23. Hagen, E. E. On the Theory of Social Changes. The Dorsey Press, 1962.

24. Hendricks, J. W. A System for Development of Mathematical Models. U. S. Naval Radiological Defense Laboratory. USNRDL-TR-749. 23 April 1964.

25. Hoselitz, B. F. and Moore, W. E. Industrialization and Society. Unesco-Mouton, 1963.

26. Huntington, S. P. Political Development and Political Decay. World Politics, v. 17, April 1965: 386-430.

27. Kershaw, J. A. Systems Analysis and Education. The Rand Corporation. Research Memorandum. RM-2473-FF. October 30, 1959.

28. LaPalombara, J. Bureaucracy and Political Development: Notes, Queries and Dilemmas. Bureaucracy and Political Development, ed. LaPalombara, J. Princeton University Press, 1963: 34-61.

29. LaPalombara, J. An Overview of Bureaucracy and Political Development. Bureaucracy and Political Development, ed. LaPalombara, J. Princeton University Press, 1963: 3-33.

30. Lerner, D. Toward a Communication Theory of Modernization. Communications and Political Development. Princeton University Press, 1963: 327-350.

31. Liveright, A. A. Strategies of Leadership. Harper & Brothers, 1959.

32. March, J. G. and Simon, H. A. Organizations. John Wiley & Sons, 1958.

33. McClelland, C. A. Systems and History in International Relations. General Systems Vol. III 1958: 221-247.

34. McLellan, D. S. et.al. The Theory and Practice of International Relations. Prentice-Hall, 1960.

35. Pye, L. W. Models of Traditional, Transitional, and Modern Communications Systems. Communications and Political Development, ed. Pye, L. W. Princeton University Press, 1963: 3-23.

36. Pye, L. W. Politics, Personality, and Nation Building. Yale University Press, 1962.

37. Rice, C. E. A Model for the Empirical Study of a Large Social Organization. General Systems Vol. VI, 1961: 101-106.

38. Runchiman, W. G. Social Science and Political Theory. Cambridge University Press, 1963.

39. Samuelson, P. A. Foundations of Economic Analysis. Harvard University Press, 1961.

40. Schramm, W. Communication Development and the Development Process. Communications and Plitical Development, ed. Pye, L. W. Princeton University Press, 1963: 30-57.

41. Siegel, B. J. Some Recent Developments in Studies of Social and Cultural Change. The Annuals, January, 1966: 137-153.

42. Schelling, T. C. The Strategy of Conflict. Harvard University Press, 1960.

43. Tead, O. Toward The Knowledge of Man. General Systems Vol. III 1958: 248-259.

44. Van Dyke, V. Political Science: A Philosophical Analysis. Stanford University Press, 1960.

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This thesis represents the beginning of a project that will study the behavior of emerging nation - states. The project purposes to reason by induction and analogy from the individual to the nation by aggregating individual needs, abilities, knowledge and decision rules in much the same manner that economists move from the micro-economics.

This thesis reports the work to date. It consists of a description of a simple aspiration model of man in an environment barren of all social interactions. The thesis represents man's efforts to utilize his environment to provide the essentials to utilize his environment to provide the essentials for survival by modeling the interfact between man and the environment in terms of man's needs, abilities, knowledge, and decision rules.

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